National Aeronautics and Space Administration

Safely Enabling Low-Altitude UAS Operations: Unmanned Aircraft System Traffic Management

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DFS Technology Conference – The Drone Challenge
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Innovate Relentlessly

Embracing innovation while respecting aviation's safety tradition

Excited	Nervous	Frustrated	Excited	Heads down	Close to impact

Unmanned Aircraft Systems Applications

Embracing innovation

Where were we?

- Lack of rule
- Gaps in concepts for expanded multiple operations
- Lack of understanding in roles/responsibilities
- Lack of requirements for safe and scalable expanded operations
- Lack of requirements for scale and scalable urban operations

Overall interest in moving forward

Where are we now?

- Part 107 operational
- Pathfinders in action
- UTM concept of operations accepted
- UTM roles/responsibilities accepted
- UTM tests show promise
- Research underway for urban operations

FAA has shown agility and NASA focused research

What's coming next?

- By 2020, 7M total and 2.6M commercial small UAS
- Urban and suburban personal air mobility operations
- UAS everywhere: in class A, B, C, D, E, and G airspace
- High altitude airspace operations (60,000 ft. and up)
- Commercial space operations

Characterizing uncontrolled and controlled operations

UTM Research Technical Capability Level

Each capability is targeted to type of application, geographical area and uses risk-based approach

Capability 1: Showed how to enable multiple Operations Under Constraints

- Notification of area of operation
- Over unpopulated land or water
- Minimal general aviation traffic in area
- Contingencies handled by UAS pilot
- Enable agriculture, firefighting, infrastructure monitoring

Capability 2: Showed How to Enable Expanded Multiple Operations

- Beyond visual line-of-sight
- Tracking and low density operations
- Sparsely populated areas
- Procedures and “rules-of-the road”
- Longer range applications

Capability 3: Focuses on how to Enable Multiple Heterogeneous Operations

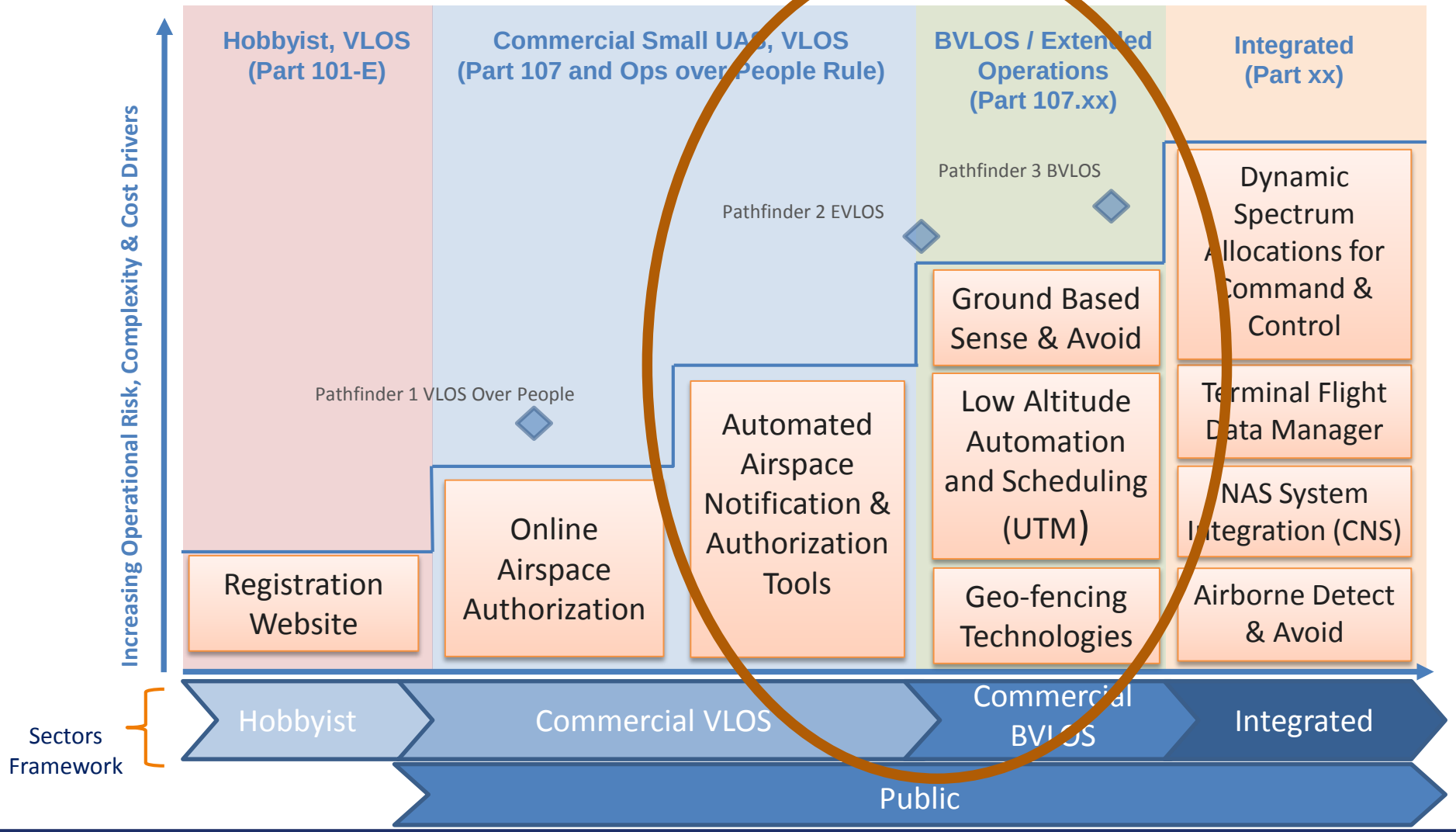
- Beyond visual line of sight/expanded
- Over moderately populated land
- Some interaction with manned aircraft
- Tracking, V2V, V2UTM and internet connected
- Public safety, limited package delivery

Capability 4: Focuses on Enabling Urban Operations

- Beyond visual line of sight
- Urban environments, higher density
- Autonomous V2V, internet connected
- Large-scale contingencies mitigation
- News gathering, deliveries, personal use

Critical Technology Enablers

Earl Lawrence, Presented at Drone Advisory Committee

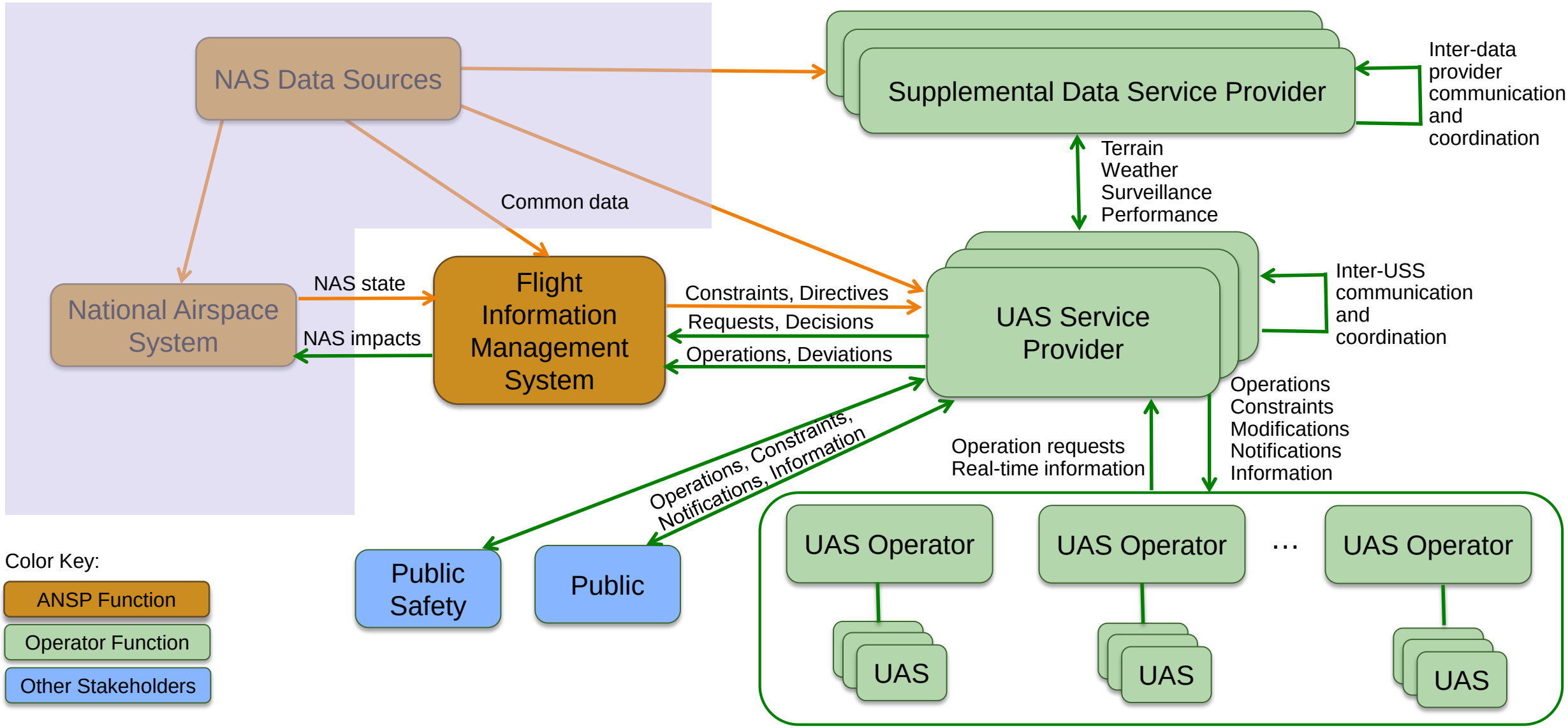


UTM Progress

- Concept of operations
- Roles/responsibilities – implications on who pays
- Information architecture paved way for FAA's RFI
- Demonstrated initial feasibility of architecture, application protocol interface based approach, and overall construct
- Data exchange and protocols
- Demonstration of UTM TCL1 with all 6 test sites
- Initial demonstration of UTM TCL2 for BVLOS requirements

UTM R&D continues to make good progress

UTM Architecture



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Stages of Traffic Management: Balancing safety, efficiency, and scalability

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UTM Key Lessons: Proving safety together

Beyond basics

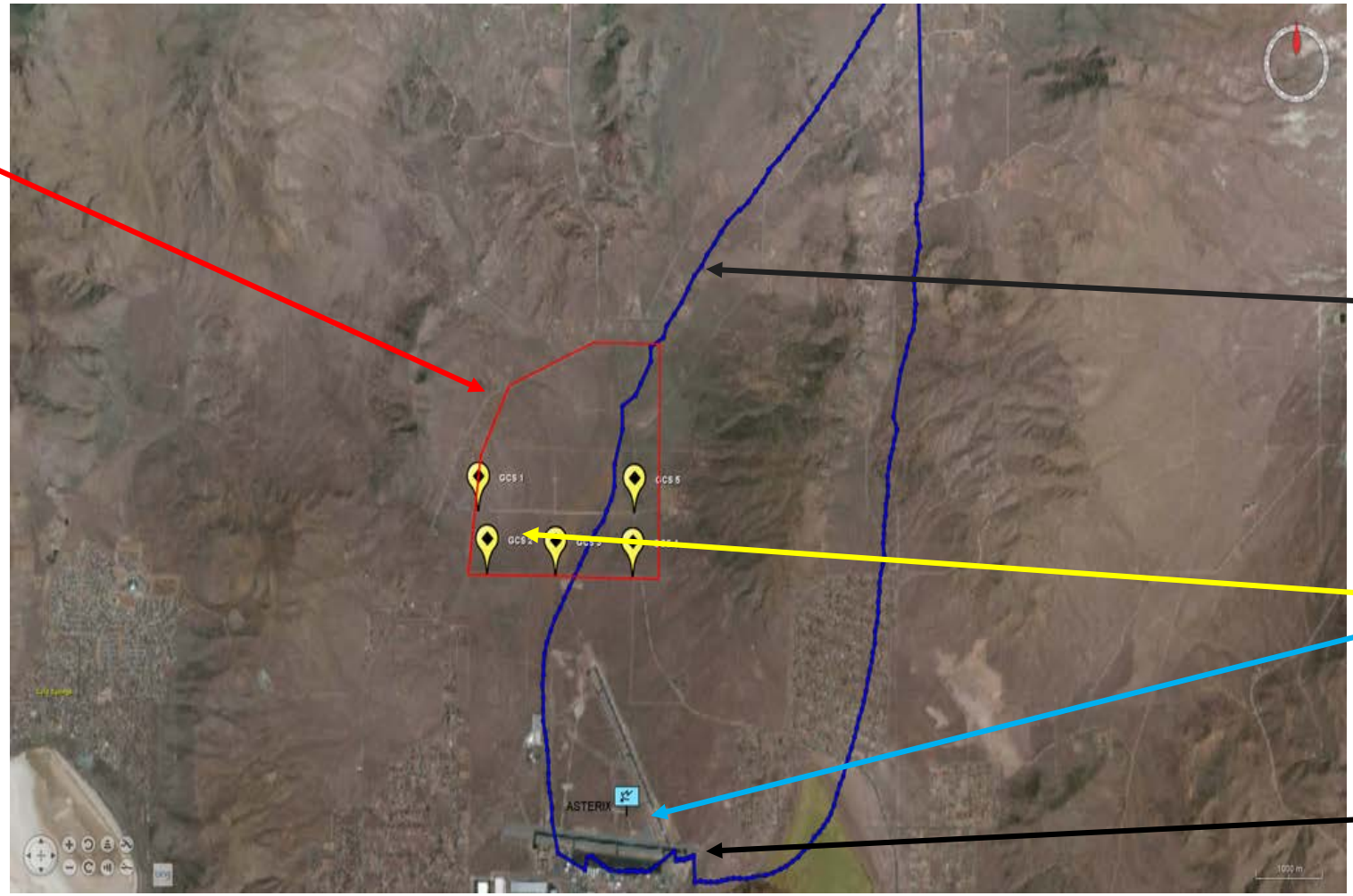
- Disruptions, off-nominals and contingencies
  - Weather and wind effects, and need for better predictions
  - Priority access: Clearing airspace based on dynamic conditions
  - Lost/delayed communications
  - Vehicle malfunctions
  - Rogue operation and its influence on other operations
  - Cyber security
  - Lack of availability of GPS and degraded conditions

Airspace operations requirements based on solid research

Safety of Operations

UTM TCL2
Drone Operations
Area

Ground
Control Stations



GA Aircraft
Track

Primary Radar
(LSTAR)

Reno-Stead
Airstrip

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National UAS Standardized Testing and Rating (NUSTAR)

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NUSTAR

- Performance data is critical to safety and acceptance
- Underwriter's laboratory for UAS
  - Weather conditions: wind, icing, fog, rain
  - Security: Spoofing, hacking, and interference
  - Noise
  - Detect and avoid tests under variety of conditions
  - Failure modes
  - Drop tests
  - Sub-system level performance (e.g., battery, propulsion)
  - Conformance to geo-fence
- Users: Insurance, regulators, manufacturers, consumers, researchers
- Forensics testing and recreation of accidents

Performance data is needed

UTM Next Steps

- Exercises with all FAA test sites for expanded/BVLOS operations
- Working groups: active collaboration
  - Concept of operations and use cases, Data exchange, Detect and avoid, Communication and navigation, and Performance
  - Spectrum and Weather
- Airspace research: Architecture, high density and constraints, airspace configurations, demand/capacity balance, communication and navigation, and contingencies
- Vehicle research: geo-fence conformance, DAA, track and locate, hazard avoidance, trajectory uncertainty, and last/first 50 feet operations
- Air/ground capabilities: Towards complex and heterogeneous operations

Culminate in joint FAA-NASA UTM pilot project

Expanding Vision

- Airspace categories: services provided and not provided by ANSP
- Ensure UTM success and deliver
- Personal air mobility – uncontrolled airspace and/or uncontrolled operation
- High altitude UTM construct for airspace operations
- Ultra high altitude construct for space traffic management
- Interest where services could be provided to improve current operations

UTM type paradigm appears to be expandable to other airspace

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Beaver is a keystone species: UTM has potential to do so!
Beavers - beavering - to beaver!
Thank you for your contributions!